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# Single and Combined Effects of Organic Selenium and Zinc on Egg, Fertility, Hatchability, and Embryonic Mortality of Exotic Cochin Hens

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## Abstract

A study was conducted to examine the effects of diets supplemented with organic selenium, (Se) and zinc, (Zn) on the performance of Cochin exotic breeder hens. Forty-two week old hens (n=120) and males (n=12) were assigned to four treatment groups of 10 females and 1 male each. Birds with no mineral supplementation (Group 1); feed supplemented with .33 ppm Se (Group 2) feed supplemented with 20 ppm Zn (Group 3), and feed supplemented with .33 ppm Se and 20 ppm Zn (Group 4). Eggs were collected for 21 days to determine egg production and egg weight. Fertility and embryonic mortality were determined by candling eggs on days 12 and 18. Hatchability was calculated on day 21 based on fertility and egg set. Results showed that egg production did not increase significantly, although birds provided feed containing Se or Se and Zn produced 4% and 6%, respectively, more eggs than the control hens. Egg fertility was similar for most treatments, but fertility of hens provided the Zn-supplemented diet, was significantly lower than fertility of other treatment groups. Hatchability based on fertile eggs was 4.6% and 3.0% higher than the control and for eggs from hens provided feed supplemented with Se or Se+Zn, respectively. Early and late embryonic mortality was significantly ( $P<0.05$ ) lower in eggs from hens provided diets containing Se+Zn, than in eggs from the control hens or hens fed diets containing Se or Zn only. In conclusion, supplementing diets of exotic hens with Se and Zn increased egg production and significantly reduced early and late embryonic death. Addition of these minerals to the diets might provide exotic bird producers a method to increase the performance of these birds.

**Keywords:** Exotic birds; Egg production; Fertility; Embryonic mortality; Hatchability

## Introduction

Due to relatively low egg and meat production as compared to most commercial breeds of broilers and layers there is little data on the production performance of exotic birds. Therefore limited data are available concerning the level of egg production, fertility and hatchability for exotic birds. Factors affecting egg production, fertility, and hatchability for exotic birds are genetics, temperature, environment, disease, incubation, sanitation, overcrowding, handling, and stress [1,2]. Fertility is based essentially on the genetic makeup of the bird [3]. Various attempts have been explored to increase fertility and hatchability in exotic birds, such as cross-breeding for hybrid vigor; increasing essential nutrients, including trace minerals in diets; UV radiation for disease control and contamination of the eggs [4].

The relationship between egg productions, the age of the hens at maturity, and egg size had been reported to affect hatchability of exotic breeds of birds [5,6]. Because of their low commercial values due to poor performance, it was hypothesized that the egg production performance of exotic birds could be improved with dietary trace mineral supplements. Therefore, the objective of the current study was to examine the effects of organic selenium (Se) and zinc (Zn), alone and combined on the overall performance of exotic breeder hens.

## Materials and Methods

### Experimental design

Experiments was conducted with one hundred and twenty 42-week-old exotic breeder hens and twelve males. Birds were separated into four treatment groups of 30 hens and three males. Birds were reared in a commercial-lighted laying hen facility. The birds were reared on floors covered with wood shavings at the Poultry Center, Prairie View, Texas.

The lighting in the house was set at 15 h of light and 9 h of dark at the start of the experiment. Birds were fed treatment diets supplemented with Se, or Zn, and Se+Zn in a 2x2 factorial arrangement design with two levels of Se (0 and 0.33 ppm), two levels of Zn (0 and 20 ppm) (Table 1). All diets were iso-caloric (2,830 ME/kg), iso-nitrogenous (17% CP), and contained 3% Ca. The four treatments were arranged into a randomized factorial design with 3 replicates of 10 hens and 1 male each. Birds were allowed to consume feed and water *ad libitum*. The duration of the experiment was 21 days. The experiment was reviewed and approved by the Animal Use Protocol of the University, with reference number 2012-0901-107.

### Data collection

Eggs were collected daily from each group and stored at 12.7°C before incubation. On the 12th day of incubation, the eggs were candled to determine fertility and early embryonic mortality. Eggs that casted no embryonic shadow were considered infertile. After eighteen days, the fertile eggs were candled again for late embryonic mortality and then transferred from the setter to the Hatcher for complete incubation. Hatchability was calculated on fertile eggs and the total eggs set.

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Ingredient	Percentage
Yellow Corn	55.93
Soybean Meal (44% CP)	22.10
Alfalfa Meal (17% CP)	5.00
Meat and Bone Meal (50% CP)	3.00
Animal and Vegetable Fat	3.00
Limestone	8.22
Di-calcium Phosphate	1.15
Iodine Salt	0.25
Vitamin Trace Mineral Premix <sup>1</sup>	1.50
<b>Calculated Values</b>	
Crude Protein (%)	17.00
ME kcal/kg	2830
Crude fat (%)	4.0
Phosphorus (available) (%)	0.35
Calcium (%)	3.20
Methionine (%)	0.34
Methionine and Cystine (%)	0.62
Lysine (%)	0.76

<sup>1</sup>As-fed basis

Per kilogram of diet: Vitamin A (as Vitamin A outtake) 12,000 IU; cholecalciferol (as-fed basis) 3000 IU; Vitamin E (as x-tocopheryl acetate) 20 IU; Menadione Sodium bisulfite, 2.0 mg; Thiamine, 1.5 mg; riboflavin, 8.0 mg; niacin, 3000 mg; pantothenic acid, 150 mg; pyridoxine, 40 mg; vitamin B12, 15 µg; folic acid, 1.0 mg; biotin, 150 µg; Cobalt, 0.2 mg; Copper, 10 mg; iron, 80 mg; Iodine, 1.0 mg; Manganese, 120 mg; zinc, 120 mg; Selenium, 0.2 mg; butylated hydroxytoluene (BHT), 150 mg; zinc bacitracin, 20 mg.

**Table 1:** Composition of diet.

Diets	Egg <sup>1</sup> Production (%)	Egg weight (g)	Fertility <sup>2</sup> (%)	Non-Fertile (%)
Control	53.00 <sup>b</sup>	44.01 <sup>a</sup>	85.00 <sup>a</sup>	15.00 <sup>b</sup>
Selenium	57.00 <sup>b</sup>	45.20 <sup>a</sup>	81.00 <sup>a</sup>	19.00 <sup>a</sup>
Zinc	52.00 <sup>b</sup>	44.51 <sup>a</sup>	75.00 <sup>b</sup>	25.00 <sup>a</sup>
Selenium+Zinc	59.00 <sup>a</sup>	46.10 <sup>a</sup>	85.00 <sup>a</sup>	15.00 <sup>b</sup>
SEM	3.30	1.22	7.46	4.73

<sup>a-b</sup>Means within a column and with no common superscripts differ significantly (P<0.05).

<sup>1</sup>Percent egg production is calculated over a 21-days period as the total number of eggs laid per treatment divided by the total number of eggs laid over 21 days.

<sup>2</sup>Percent fertility is based on the number of eggs set, and candled on day 12 of incubation.

**Table 2:** Effects of organic selenium and zinc on total egg production, egg size and fertility of exotic hens.

## Statistical analysis

Data were subjected to analysis of variance using general linear models procedures [7] with each replicate pen as an experimental unit. The model included replication, Se and Zn treatments and interaction of Se+Zn. Significant differences in percentage egg production, fertility, hatchability, early and late mortality were determined using Duncan's Multiple Range Test of means. The level of significance was set at P<0.05.

## Results and Discussion

The results of the different variables being analyzed are presented in table 2. Egg production of hens provided the diet supplemented with Se+Zn was significantly higher (P<0.05) than egg production by hens provided the other treatments. Egg weights were not significantly different among the 4 treatment groups. Fertility was similar for all treatments, except for the Zn-supplemented group, which was significantly lower (75%) than the other three treatment groups. Non-fertile eggs for groups given Zn only (25%) and Se only (19%) were significantly (P<0.05) higher compared to 15% for the control and

Se+Zn groups, respectively.

Eggs were candled on the 12<sup>th</sup> day for early embryonic death and on the d 18 for late embryonic death (Table 3). Early and late embryonic death was significantly lower (P<0.05) in eggs of hens provided a diet containing Se+Zn, whereas late embryonic death was significantly lower in eggs of hens provided a diet containing Se only. Supplementing the diet of hens with Se, Zn or Se+Zn produced no significant changes in the hatchability of eggs; however, results show that hatchability on eggs set from the Se+Zn treated birds was 3.3% higher than the control eggs. The reported results suggested that mineral nutrition greatly affects reproductive performance of the exotic birds. The hatchability rate of total eggs set, which ranged between 48.2% to 56.6%, and fertile eggs as high as 66.6%, suggests improvement regardless of how small will result in significant profit for the industry [5].

Rapid growth and development of embryos can result in the production of free radicals and hence growing broilers need higher levels of antioxidants [8]. To insure protection from free radicals, antioxidants are required, of which selenium is a core element of GSH-Px. The selenium used in this study was in an organic form which is reported to have a higher bioavailability than non-organic Se. Similar to growing broilers, young growing embryos develop under intensive conditions that require a robust and efficient immune system, which is dependent on selenium status. Placha et al. [8] also suggested supplementation with organic selenium is essential for life, because it prevents the blood phagocytic suppression and changes the glutathione peroxidase activity in duodenal tissue in broilers caused by sub-toxic levels of deoxynivalenol in the feed.

Hatchability is related to egg fertility and embryonic mortality throughout the hatching process. In the current study, hatchability was calculated on total eggs set and on fertility (Table 3). Also differences in hatchability among flocks increases with flock age [9]. The age of the breeder hens in this study was 42 wk, and this may have been one of the factors that produced low hatchability [10]. Stated that when hens reach the age of 30 wk, there is a slightly lower hatchability, which could be related to less fertility and greater incidence of non-viable series of eggs. Hatchability for eggs of older breeders decreases because of change in egg quality and failure to adjust the incubation condition [11,12]. It was further stated that as the hen ages, the albumen quality, which is the main source protein to the embryo development deteriorates. The birds in the current study came available at 42<sup>nd</sup> week. The improvement in hatchability for eggs from hens fed selenium and zinc supplementation could be due to the effect of selenium and zinc in maintaining the integrity of the albumen. Eggs from older breeders are known to hatch

Diets	Embryonic Death		Hatchability	
	Early <sup>1</sup>	Late <sup>2</sup>	Eggs Fertile	Eggs Set
	----- % -----			
Control	3.30 <sup>a</sup>	1.50 <sup>a</sup>	63.6 <sup>a</sup>	53.3 <sup>a</sup>
Selenium	3.70 <sup>a</sup>	0.75 <sup>b</sup>	68.2 <sup>a</sup>	48.2 <sup>a</sup>
Zinc	3.20 <sup>a</sup>	1.50 <sup>a</sup>	61.8 <sup>a</sup>	51.8 <sup>a</sup>
Selenium+Zinc	2.60 <sup>b</sup>	0.50 <sup>b</sup>	66.6 <sup>a</sup>	56.6 <sup>a</sup>
SEM	0.45	0.89	2.87	3.48

<sup>a-b</sup>Means within a column and with no common superscripts differ significant (P<0.05).

<sup>1</sup>Early embryonic death was calculated on 12<sup>th</sup> day of incubation based on the number of eggs candled.

<sup>2</sup>Late embryonic death was calculated on the number of eggs candled on 18<sup>th</sup> day of incubation based on fertility.

**Table 3:** Effects of organic selenium and zinc single and combined on early and late embryonic mortality and hatchability.

earlier and suffer more from post-emergent holding in the hatchery. In this study we noticed great variation (not recorded) in the arrival of the chicks at 21 days in the control eggs.

The low hatchability reported in the current study could also be due to egg storage length. It was concluded that the real egg storage length is at least 1 to 4 days for hatching eggs [11]. They also stated that egg storage at the hatcheries decreased hatchability significantly. The egg collection and storage length in the current study ranged from 1 to 21 days, because of the small flock size and the need to get a representative sample of eggs. The combination of selenium and zinc supplementation appeared to be beneficial; as the hatchability from selenium and zinc treatment improved the level of hatchability compared to birds provided a diet that was not supplemented with these minerals. Egg storage depresses albumen quality affects embryonic viability as the flock ages, and results in a lower percentage of healthy day-old chicks [11,12]. Another factor that may have influenced the low hatchability observed in the current study could be the breed of the hens. The literature reported that there is a significant difference in hatchability among birds of exotic birds. Breeds respond differently to hatchability, and it is known to vary for different strains [10]. This observation suggests that different birds require different management in the laying programs as well as the hatcheries. The hens in the current study were exotic breeds, not commercial.

## Conclusion

The limited attention that is being placed on the availability of antioxidants in feeds for poultry. Antioxidants block the effects of free-oxygen radicals, which destroy the cellular membranes. The egg yolk which is the main source of energy to the developing embryo, being lined with phospholipids, is sensitive to oxidation. The erosion of the yolk membrane shortens the life of the developing embryo. Most feed formulation incorporates vitamin E as the primary antioxidant, however, selenium, which is the core element in the synthesis of the body's natural defense enzyme (GSP-Px), can serve as an additional source of antioxidant to scavenger free radicals. Zinc, which is the core element of insulin, increases the bioavailability of glucose, which is converted into energy for the embryo. Therefore, in conclusion; the present study suggests that it is possible to improve fertility and hatchability of exotic breeds by supplementing the feed provided to these birds with Se and Zn.

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